What is claimed is:

1. An electric machine with a multi- pole rotor comprising:

- ferromagnetic poles separated from each other by radially oriented slots, wherein the width of said slots changes stepwise in tangential direction; and
- a plurality of permanent magnets per pole, wherein said magnets are placed into said radial slots between adjacent poles in such a manner that the total width of magnets in a given radial slot varies from the bottom to the top of the slot.

2. A rotor, as set forth in claim 1, wherein said permanent magnets have rectangular shapes.

3. A rotor, as set forth in claim 1, wherein said permanent magnets are predominantly tangentially magnetized.

4. An electric machine with a multi- pole rotor comprising:

- ferromagnetic poles separated from each other by radially oriented slots, wherein said slots are trapezoidally shaped; and
- a plurality of trapezoidally shaped permanent magnet in each said slot.

5. An electric machine with a multi- pole rotor comprising:

- ferromagnetic poles separated from each other by radially oriented slots, wherein said slots are trapezoidally shaped,
- a plurality of trapezoidally shaped permanent magnets in each said slot, and
- a plurality of non- magnetic wedges per each said rotor pole.

6. A synchronous machine with a rotor comprising:

- a plurality of iron core segments per pole;
- a plurality of permanent magnets per pole;
- an optional squirrel cage; and

- a stator with two or more separate windings, or a winding capable to generate more than one polarity of the air gap field, such as Dahlander pole- changing winding, a pole-amplitude modulated winding, a pole- phase modulated winding etc.

7. A rotor, as set forth in claim 6, wherein said permanent magnets have rectangular shapes.

8. A rotor, as set forth in claim 6, wherein said permanent magnets have trapezoidal shapes.

9. An electric machine with a multi- pole rotor comprising:

- a plurality of tangentially magnetized permanent magnets;
- a plurality of radially magnetized permanent magnets, and
- a plurality of coils.

[What is claimed is:]

1. [A rotor of a synchronous machine, comprising:]

[an iron core segment per pole; and]

[at least two permanent magnets per pole.]

2. [A rotor, as set forth in claim 1, wherein said rotor has a plurality of poles.]

3. [A rotor, as set forth in claim 1, wherein said permanent magnets have rectangular shapes.]

4. [A rotor, as set forth in claim 1, wherein said permanent magnets are tangentially magnetized.]

5. [A rotor of a synchronous machine, comprising:]

[two iron core segments with additional pole piece per pole; and]

[one permanent magnet per pole.]

6. [A rotor, as set forth in claim 5, wherein said rotor has a plurality of poles.]

7. [A rotor, as set forth in claim 5, wherein said permanent magnets have trapezoidal shapes.]

8. [A rotor, as set forth in claim 5, wherein said permanent magnets are tangentially magnetized.]

9. [A synchronous machine with a rotor comprising:]

[one or more iron core segments per pole; and]

[one or more permanent magnets per pole; and]

[an optional squirrel cage;]

[and the stator with:]

[Dahlander pole- changing winding, or]

[pole- amplitude modulated winding, or]

[pole- phase modulated winding with toroidal coils, as described in US Patent 5,977,679.]

10. [A rotor, as set forth in claim 9, wherein said rotor has a plurality of poles.]

11. [A rotor, as set forth in claim 9, wherein said permanent magnets have rectangular shapes.]

12. [A rotor, as set forth in claim 9, wherein said permanent magnets are predominantly tangentially magnetized]

13. [A synchronous machine with a rotor comprising:]

[one or more iron core segments per pole; and]

[one or more permanent magnets per pole; and]

[an optional squirrel cage;]

[and the stator with:]

[Dahlander pole- changing winding, or]

[pole- amplitude modulated winding, or]

[pole- phase modulated winding with toroidal coils, as described in US Patent 5,977,679.]

14. [A rotor, as set forth in claim 13, wherein said rotor has a plurality of poles.]

15. [A rotor, as set forth in claim 13, wherein said permanent magnets have trapezoidal shapes.]

16. [A rotor, as set forth in claim 13, wherein said permanent magnets are predominantly tangentially magnetized.]

17. [A rotor of a synchronous machine, comprising:]

[one iron core segment per pole;]

[one tangentially magnetized permanent magnet per pole; and]

[one or more coils per pole.]

18. [A rotor, as set forth in claim 17, wherein said rotor has a plurality of poles.]

19. [A rotor, as set forth in claim 17, wherein said permanent magnets are tangentially magnetized.]

20. [A rotor, as set forth in claim 17, wherein said coils can be separately excited.]

21. [A rotor of a synchronous machine, comprising:]

[one iron core segment per pole;]

[one tangentially magnetized permanent magnet per pole;]

[one radially magnetized permanent magnet per pole; and]

[one or more coils per pole.]

22. [A rotor, as set forth in claim 21, wherein said rotor has a plurality of poles.]

23. [A rotor, as set forth in claim 22, wherein said coils can be excited separately from each other.]

24. [A rotor of a synchronous machine, comprising:]

[two iron core segments per pole; and]

[two tangentially magnetized permanent magnets per pole.]

25. [A rotor, as set forth in claim 24, wherein said rotor has a plurality of poles.]

General remarks to detailed action of May 15, 2001

Application No. 09/517,256

1. None of the electric machines in patents quoted by the examiner is either capable of, or is claimed to be capable of having the field of its permanent magnets controlled in the manner proposed in my application. The capability of partial remagnetization of permanent magnets with stator current for purpose of flux control is nowhere stated in these patents;

2. The unique feature of magnet field control in my application is based upon discrete or continuous change of magnetized length along magnet radial direction, which makes possible the localization of effects of demagnetization current to a certain magnet radial height. None of the magnets referred to in quoted patents can be geometrically partially demagnetized by a component of stator current;

3. In none of the embodiments in the quoted patents a plurality of permanent magnets per pole has been mentioned, a property crucial for some embodiments in my application.

Particular objections to examiner's action

are given in the following table, starting with pt. 13 from examiner's document "Detailed Action".

a2

Pt.	Examiner's comments as specified in Detailed Action of 05/15/01	Applicant's objections
13.	"... **Herschberger (US 4,327,302)** discloses in Figures 4- 1 invention as claimed: a rotor comprising having a plurality of poles having an iron core segment 53 and two rectangular permanent magnets 89 and 91 per each pole"	- Herschberger has neither in specifications nor in claims specified <u>two</u> rectangular permanent magnets per each pole.; - In Fig. 4- 11, and especially Fig. 19 of US 4,327,302 one can see that only <u>one</u> permanent magnet per pole is disclosed (<u>eight</u> poles as specified schematically in Fig. 19 represent four physical poles 49 and four physical poles 53 in Figs. 1, 4- 11. Four permanent magnets 89 and four permanent magnets 91 in Figs. 4- 11 make total of <u>eight</u> permanent magnets in rotor.) Therefore, the machine proposed by Herschberger has 8 magnets per 8 poles, or <u>one magnet per pole</u>.
14.	**Reiter Jr. et. al. (US 5,191,256)**	The claims 7, 8, 14, 26, and 27 of US 5,191,256 contain following logically ill- conditioned descriptions: - "... and wherein said at least one magnet includes a pair of magnets ..." or - " ...said at least one magnet includes three magnets ..." If a magnet includes another pair of, or even three magnets, then the descriptions above allow that each magnet in the pair or the triplet includes another pair or three magnets, further allowing each magnet of new pairs and triplets to include new pairs and triplets of magnets etc. etc.. These descriptions are logically inconsistent and contradictory. The ill- conditioned claims 7, 8, 14, 26, and 27 of US 5,191,256 should not be taken as a basis for rejection of a sound engineering concept presented in my application.

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14.	"**Reiter Jr. et. al. (US 5,191,256)** disclose in Figures 7- 10 invention as claimed: a rotor having a plurality of poles and comprising an iron core segment 18 and a plurality of tangentially magnetized, <u>rectangular</u> permanent magnets <u>17w, 17x and 17y</u> per each pole."	Reiter Jr. et. al did not disclose in Figures 7- 10 an invention comprising an iron core segment 18 and a plurality of tangentially magnetized, <u>rectangular</u> permanent magnets <u>17w, 17x and 17y</u> per each pole, because: - in none of Figs. 7- 10 the magnets 17y are used <u>together</u> with magnets 17x and 17w in the same preferred embodiment; - the magnets 17y have a form which is not rectangular (Fig. 10).
14.	"Re claims 5, **Bertram et al.** disclose in Fig. 3 a rotor having two iron core segments 40 and 18 with an additional pole member 18 and a permanent magnet 17 per rotor pole, in Figure 10 an additional pole member 17y and a permanent magnet 17z in shape of a trapezoid, and in Figure 7 a tangentially magnetized magnet 17"	The reference to **Bertram et al.** without having the corresponding patent number could not be followed. However, based upon previous context one can assume that instead of Bertram, Reiter should have been referred to at this place. If this is true, i.e. had the examiner meant **Reiter et al.** instead of **Bertram et al.**, and had he meant US 5,191,256, then following is to be objected: - nowhere in US 5,191,256 the word "trapezoidal" is mentioned, and nowhere in this patent the form of magnet 17z is specified as to be trapezoidal; - in claims 5, 6, 13, 24, 25, 33, 39, 40 and 41 of US 5,191,256 the V- shaped and U- shaped magnets are specified. The <u>V- shape</u> and <u>U- shape</u>, however, do not mean <u>trapezoidal</u> form; - the magnet 17z in Fig. 10 carries notation "N" on the upper base and "S" on the lower base, which means that it is obviously magnetized <u>along</u> the trapeze height. In my patent application the trapezoidal magnets are always magnetized <u>perpendicular</u> to the trapeze height.

a2 cont.

15., 16.	"**Zajc et al. (US 5,744,888)** … disclose in Figures 1, 6, and 7- 9 invention as claimed: a rotor having a plurality of poles and comprising an iron core segment 9 and a plurality of tangentially magnetized, rectangular permanent magnets 1 per each pole, and one or more separately excited coils per pole"	Zajc et al. (US 5,744,888) did not disclose in Figures 1, 6, and 7- 9 invention as claimed: a rotor having a plurality of poles and comprising an iron core segment 9 and a plurality of tangentially magnetized, rectangular permanent magnets 1 per each pole. In none of their claims Zajc et al. mention more than one permanent magnet per pole. In Zajc's specification permanent magnets 1 are mentioned 8 times, but never as a plurality of magnets per pole. Zajc et al. describe their invention as: - the embodiment in Fig. 7: "… the externally located rotor 20 having ninety poles..", whereas in the same Figure one can count exactly 90 magnets. This embodiment has only one magnet per rotor pole; - the embodiment in Fig. 9A has "… fifty rotor poles.." and one can count exactly fifty radially magnetized permanent magnets 29, i.e., again only one rotor magnet per pole.
18.	"**Broadway et al. (US 3,686,553)** disclose in Figures 7- 13 a synchronous machine with a rotor comprising one or more iron core segments per pole, and a stator with a pole amplitude modulating winding. However, Broadway et al. fail to disclose one or permanent magnets per pole".	Broadway et al. could not disclose a conventional PM rotor with their dual- polarity stator winding, because a rotor of a conventional PM machine (but not of machines disclosed in my application) can have only a single number of poles, and as such can create a torque only at one stator winding polarity.

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18.	"It would have been obvious to one having ordinary skill in the art at the time the invention was made to design the machine as taught by **Broadway et al.** and to provide the rotor having iron core segment and one permanent magnet per pole as taught by **Li et al.** for the purpose of providing two sources of torque, thus increasing the torque output per phase without significant increase of the machine cost.	The machine patented by **Li et al. (US 5,973,431)** can operate only with a single pole number, whereas Broadway et al. propose a self- cascaded machine that can operate at two polarities, i.e. it can have 2p poles and 2q poles. A combination of Broadway et al. patent and Li et al. patent cannot function properly. This is probably the reason why such a combination has not been patented yet. Broadway et al. describe in their claims either a wound rotor, or a reluctance type rotor. The rotors of my machine contain always permanent magnets, and as such they belong to a different category of electric machines.
18.	"Re claim 15, it would have been further obvious to one having ordinary skill in the art at the time the invention was made to design the combined with trapezoidally shaped magnets for the purpose of accurately follow the rotor shape since applicant has not disclosed that the trapezoidally shaped magnets solve any stated problem or is for any particular purpose and it appears that the invention would perform equally well with rectangular or arc shaped magnets…"	The purpose of accurately follow the rotor shape was not mentioned in my application, because this is irrelevant for my disclosure. In my application I have elaborated in detail how trapezoidally shaped magnets solve the problem of flux control in PM machines. In the chapter "Detailed description of the drawings" of the application on page 8, lines 6 – 9, the exact description of trapezoidal magnet function is given: "The trapezoidal form of permanent magnets enables variation of the radial height of remagnetized portion of magnets (5) as a function of the stator control current."